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A PRELIMINARY REPORT ON THE SCALE MATSUCOCCUS BISETOSUS MORRISON, AS A POSSIBLE CAUSE OF JUVENILE AND MATURE PONDEROSA AND JEFFREY PINE DECADENCE IN THE PACIFIC NORTHWEST

by
H. L. McKenzie
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Forest Insect Laboratory
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APPROVED BY:

J. M. MILLER
Senior Entomologist, In Charge

SUBMITTED BY:

H. L. MCKENZIE
Junior Entomologist

A PRELIMINARY REPORT ON THE SCALE, MATSUCOCCUS BISETOSUS MORRISON, AS A POSSIBLE CAUSE OF JUVENILE AND MATURE PONDEROSA AND JEFFREY PINE DECADENCE IN THE PACIFIC NORTHWEST

FOREWORD

The data included in this preliminary report have been assembled in order to present the fragments of information that have been accumulated on this subject during the past two years. The report is not intended to be final in any sense, but only to show the many cases of Matsucoccus bisetosus scale infestations that now appear to be fairly generally distributed throughout the Pacific Northwest. It is hoped that the discoveries made thus far will tend to stimulate more activity along the lines of Matsucoccus investigations and that ultimately the true significance of scale insect attacks on pines may be more fully appreciated.

The material that has been collected will be discussed in this report as a series of case histories, because so little is known as yet regarding the biology of this scale insect and the injury it produces on living trees. This preliminary information has been assembled primarily as a basis for plans on which to organize a program of study for 1940. No attempt will be made to present an analysis or final conclusions until further studies have been completed.

WILLOW SPRING AND HAT CREEK, LASSEN AREA - 1936

The scale insect, Matsucoccus bisetosus was described by Dr. Harold Morrison[1] from specimens collected by Dr. F. C. Craighead, August 8, 1936, on Pinus ponderosa near Willow Spring, Lassen National Forest in California. The present author made collections of the scale on July 26 and August 23, 1938 from juvenile trees of the same host near Hat Creek, Shasta County, California. These infested trees showed evidence of much bark roughening and cracking on the branches and trunk (Figure 1A). The scale was, as far as could be determined at the time, causing much decadence of the juvenile ponderosa pine stands in certain areas near the Hat Creek Laboratory. The needle complement on these trees was much reduced as a result of the scale feeding on the stems. Some flagging was noted on the infested trees, and there was evidence of previous branch killing. Figure 1B is a lightly infested tree and as can be seen the needle complement is apparently quite normal. This tree was situated about three hundred feet from the tree shown in Figure 1A.

1--1939. Morrison, H. Descriptions of new species of Matsucoccus. (Hemiptera: Coccidae). Ent. Soc. Wash. Proc., 41:1-20

1A 1B

Figure 1 A. A juvenile ponderosa pine located near the Hat Creek Laboratory, Shasta County, California, heavily infested with Matsucoccus bisetosus Morrison scale. There was evidence of much bark roughening and cracking on the branches and trunk of this tree, and the needle complement was much reduced as a result of scale feeding. Some branch killing had already occurred on the tree at the time this photograph was taken. Photo by R. C. Hall.

B. Another juvenile ponderosa pine, situated about 300 feet from the tree shown in Figure 1A, lightly infested with same scale insect. The needle complement on this tree was apparently normal and the tree appeared to be in vigorous good health. Photo by R. C. Hall.

Matsucoccus bisetosus is capable of causing branch decadence and this has been previously reported upon by the present author in the Bureau of Entomology and Plant Quarantine News Letter for March 1939, vol. VI, No. 5, page 9, paragraph 3.

BURNS, OREGON - 1938

On November 26, 1938 Mr. F. P. Keen, of the Portland, Oregon laboratory, sent branches of young ponderosa pine that were heavily infested with this same Matsucoccus scale, from near Burns, Oregon, to the Forest Insect Laboratory at Berkeley, California. In this area, according to Mr. Keen, the infested trees showed badly deformed main lateral leaders, pale and short needles, and canker-like swellings on the twigs (Figure 2).

Figure 2. Branches collected from young to middle aged Pinus ponderosa trees at Burns, Oregon. These stems were heavily infested with Matsucoccus bisetosus scale. The infested trees from which these stems were cut showed badly deformed main lateral leaders, pale and short needles, and canker-like swellings on the twigs.

Mr. Keen further states that the Junior Forester who collected the material reports that there were several hundred acres very badly stunted and galled in this manner. An examination of this material made by the author indicated that the natural mortality of this scale in Oregon was very low, and, as a consequence, much injury was being caused.

BLACK'S MOUNTAIN EXPERIMENTAL FOREST, LASSEN AREA - 1939

During the 1938 season there was a mature ponderosa pine tree (39W/105 Compartment GB 10) on the Black's Mountain Experimental Forest in Lassen County, California that was rated or classified as a risk 1 type, (a very good tree), and at that time it was assumed that this tree would be of relatively low hazard to barkbeetle attack, at least for several years to come. During the early 1939 season, however, the tree was again examined and reclassified as a risk 4 type (a decadent or poor tree), and during the summer of this same year it was attacked and killed by Dendroctonus brevicomis. The tree was felled during October 1939 and a careful analysis for the presence of feeding flathead borers or other insects was made. There were no flathead larvae present, and the tree appeared to be free of any insect invasion prior to the time the bark-beetles attacked and killed it. At that time Messrs J. Bongberg and J. M. Miller collected branch and bole samples from the tree and these were brought into the Berkeley laboratory by Mr. Miller for an examination. The branches were examined under the low power microscope for Matsucoccus scale. On the branches three species of Matsucoccus were present feeding intermixed under the bark scales, and in the crotches where the small branchlets arise from the larger stems. The species concerned were: Matsucoccus bisetosus Morrison, M. californicus Morrison, and Matsucoccus sp. (either new or perhaps secretus). Matsucoccus bisetosus appeared to be the most abundant species.

Preadults of the Matsucoccus species were observed in almost every instance in the crotches where the small branchlets arise from the larger stems. In these crotches where the scale insects were present there was much resining (Figure 3). This resining appears to have retarded the normal physiological functions of the branch and as a result the foliage had suffered severely. The current needles on these Matsucoccus infested stems were very much shortened (see Figure 3), and the foliage surface in general appeared to be much reduced as a result of premature falling of the older needles. There was a tendency toward what has been commonly called a "mule-tail" effect of the branches, there being nothing left but a small tuft of needles at the end of the stems.

As a follow-up of this discovery the author made a trip to the Black's Mountain Experimental Forest on November 7, 1939, and there collected branch samples, at random, from three mature ponderosa pines (all with diameters of 30" or more) that were felled by a CCC crew working on the experimental plots. It was interesting to note at the time that some

Figure 3. Left: Branch from a decadent mature ponderosa pine tree on the Black's Mountain Experimental Forest, Lassen County, California, infested with three species of Matsucoccus scale. The most prevalent species appeared to be Matsucoccus bisetosus and the preadults of this and the other species were found in the branchlet crotches. The arrows point to the resining in the branchlet crotch.

Right: The current needles on these scale infested stems were apparently much shortened, and this may be the result of scale feeding.

of the branchlets arising from larger branches had noticeably longer current needles than did others growing from the same branch. It was suspected that this might be the result of scale work, and that some of the branchlets were more heavily infested than others. The trees from which the samples were cut were decadent to the extent that they were classified as risk 3 types and had been as a consequence, marked for removal. They were not, however, the poorest type tree on the experimental plots.

Silver nitrate conduction tests were initiated on both the branches collected by Bongberg and Miller as well as on those collected by the author in an effort to determine if the lesions in the branchlet crotches, produced by feeding scale, interfered with the normal physiological functions of the stem. The technique employed was the same as that recently reported on by Johnson[2] which consisted of applying a two- and one-half percent silver nitrate solution in 20% ethyl alcohol through a rubber tubing attached to the lower cut end of the sample stem. After application of the silver nitrate, the sample stem was removed from the tubing, split longitudinally, and placed in an elon-hydroquinone developer (D 72, Eastman Kodak Company). After development the split stems were fixed in "hypo". The samples were then washed in flowing water for ten minutes or more and later dried out for photographing.

Where the Matsucoccus scale were feeding in the crotches and where resining and pitching were observed as a result of this insect activity the conduction of silver nitrate was definitely retarded (Figure 4, upper right). Apparently the infested branchlets were obtaining their food principally from those conduction cells on the underside of the stem only, and it is reasonable to assume that such infested branchlets would ultimately perish. This condition existing over a period of time would ultimately put the mature pines in a state of decadence, and this type of tree we suspect is more susceptible to bark-beetle attacks.

CORTE MADERA, LAGUNAS AREA - 1939

On November 10, 1939 Messrs J. M. Miller, S. T. Carlson and Ranger J. Stevenson collected scale infested branches from mature Pinus jeffreyi trees at Corte Madera, Cleveland National Forest near San Diego, California. The species of scale was identified by the author as Matsucoccus bisetosus Morrison. Their notes pertaining to the type of trees attacked are as follows: "advance reproduction to mature trees, and in one large group of mixed age classes." Several Kodachrome pictures were taken of these bisetosus attacked trees by Mr. Miller and black and white photographs have been prepared from two of these colored slides for inclusion in this report (Figure 5). Here again the same species of scale, bisetosus, was found feeding on the branches and stems and particularly in crotches of small branchlets.

2--1939. Johnson, J. W. Silver nitrate as a stain for wood conduction studies. Berkeley, Station Report.

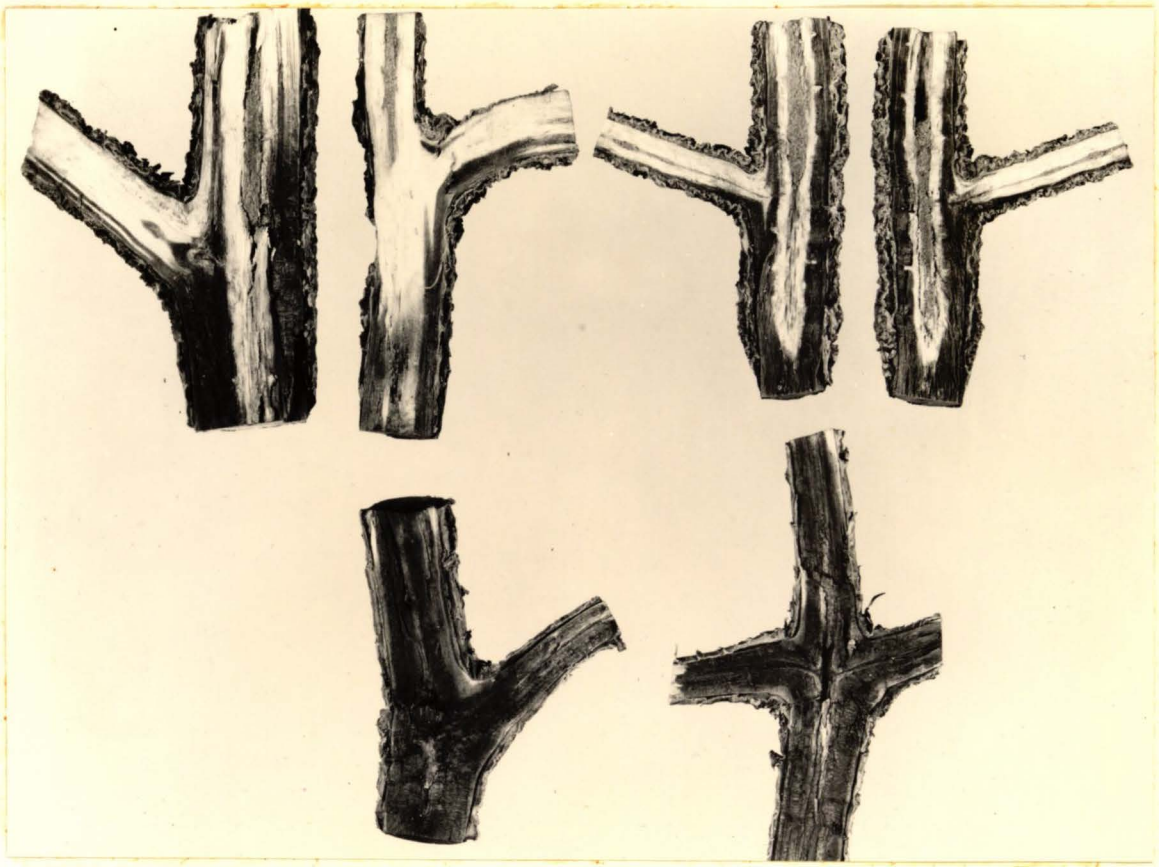

Figure 4. Upper right: Matsucoccus bisetosus scale infested stems collected from the Black's Mountain Experimental Forest, Lassen County, California, on which silver nitrate conduction tests were run. Note particularly that in the upper crotches where preadult scales are commonly found feeding, that conduction was completely retarded. The needles and stems in this case were apparently obtaining most of their food from those conduction cells on the underside of the branch.

Upper left: Ponderosa pine twigs infested with Matsucoccus bisetosus scale collected from near Middletown, Lake County, California, on which the same test was conducted. Here again there was definite stoppage as a result of necrosis and resining caused by feeding scale in the branchlet crotches.

Bottom: Silver nitrate tests run on these two normal uninfested ponderosa pine stems show good conduction in the crotches of these stems.

Figure 5. Above: A mature Jeffrey pine tree infested with Matsucoccus bisetosus scale. This tree was located at Corte Madera, Cleveland National Forest near San Diego, California. Photo by J. M. Miller.

Below: Close-up view of a few flagged branches on the tree shown above.

CUYAMACA STATE PARK, LAGUNAS AREA - 1939

At the Cuyamaca State Park in Southern California, the same scale was again found on branches of Pinus jeffreyi collected and sent to the Berkeley Laboratory on November 11, 1939, by Mr. J. M. Miller. In this case, according to Mr. Miller, flagging of the branches was noted in the lower and middle crowns of mature trees. Matsucoccus bisetosus was commonly observed in the crotches where the small branchlets arise from the stem (Figure 6). Adventitious buds are common on stems heavily infested with this scale insect.

Figure 6. Matsucoccus bisetosus scale infested stems from mature Pinus jeffreyi trees collected at the Cuyamaca State Park in California. Arrows point to feeding preadults found infesting the branchlet crotch. There appears to be a tendency toward the production of adventitious buds on stems heavily infested with this scale.

MIDDLETOWN, LAKE COUNTY - 1939

Another infestation of Matsucoccus bisetosus scale was observed on August 24, 1939, about one and one-half miles south of Middletown, Lake County, California. This scale infestation was very severe and some of the trees have practically the entire top crown killed outright (Figure 7). Others have the middle crown killed with

Figure 7. Ponderosa pine trees near Middletown, Lake County, California, severely infested with Matsucoccus bisetosus scale. Note the excessive branch flagging on these trees. Some of the scale infested trees have been recently attacked by Ips and Dendroctonus beetles. Photo by V. O. Sandberg, Forest Service Ranger, Region 3.

the top still alive. At first glance the infestation looks like bark beetle damage, but upon a more critical examination of the branches it will be noted that the injury is quite different. The bark on the infested stems was much roughened and cracked and there was considerable resining (see Figure 8). The roughening and cracking of the bark appeared to be associated with feeding Latsucoccus scale and it was easy to locate the preadult stage beneath this roughened surface. Feeding scale were commonly observed im the branchlet crotches and the same type of resining as described before was in evidence in these areas.

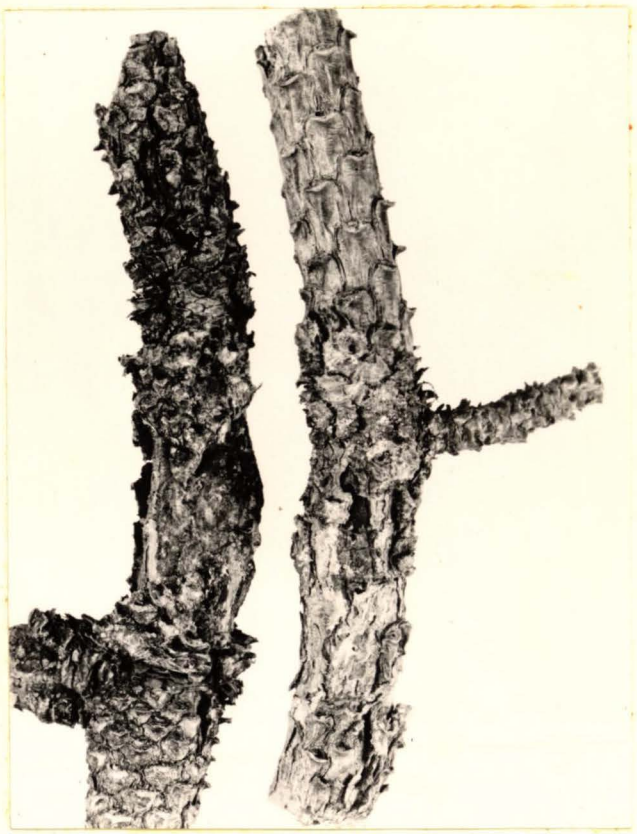

Figure 8. Stems collected from bisetosus scale infested trees near Middletown, California. The cracking and roughening of the bark is apparently associated with feeding scale. Resining was also noted.

Silver nitrate conduction tests were run on infested stems from these trees, and the same phenomenon existed as in those tests of the Black's Mountain stems (see Figure 5, upper left). Histological sections show a break-down of cell walls and necrosis in the branchlet crotches.

These scale infested trees have recently been attacked by Ips and Dendroctonus brevicomis bark beetles. It appears that in this particular case, the Matsucoccus scale attack actually preceded bark beetle invasion. The scale infested trees were examined in late summer and it was not until late fall that they were attacked by bark beetles. It is suspected that similar conditions exist in pine stands elsewhere in the Pacific Northwest since infestations of the bisetosus scale appear to be rather widespread.

GRAND CANYON, ARIZONA - 1937

Another somewhat similar case has been observed on Pinus edulis on the South Rim of the Grand Canyon in Arizona. In this instance, the needles on the pinon trees were severely infested with Matsucoccus acalyptus Herbert and there was evidence of heavy defoliation. According to Mr. Miller a few of these trees had apparently been subsequently attacked by Ips bark beetles.

PLANS OF STUDY FOR 1940

One can readily visualize how the Matsucoccus scale infestations on the branchlets and stems may contribute to the decadence of mature pines. The gradual killing of the smaller branchlets and stems would ultimately lead to large branch killing, and it is thought that this may be what has happened to so many of our mature ponderosa pines in northeastern California. The needle complement being much reduced as a result of scale activity would, no doubt, influence tree vigor and it is reasonable to assume that such weakened trees would be much more susceptible to bark beetle attacks.

Three different phases of work should be initiated during the 1940 season in order to obtain a more thorough knowledge of this Matsucoccus problem. These phases of work are as follows:

1. Biology - The first major effort should be concentrated on seasonal history and habits of the scale insect. Very little is yet known as to when during the year the adult females migrate and lay eggs. Nothing is known about the developmental stages of the larvae of this insect or how the scale overwinters. This information may be obtained through periodic collections in the field.

2. Demonstration experiments to determine whether typical injury can be induced by artificially infesting healthy trees - Both potted seedlings and uninfested trees growing naturally in the forest near the Hat Creek Laboratory

will be artificially infested with this scale insect during the 1940 field season. Ponderosa pine seedlings held in the Berkeley Insectary will likewise be infested as a double check on tree injury. General branch and tree decadence should be noticeable sometime in the future if successful tree infestations have been established.

3. Studies of injury and effect upon tree functions -
This study can be worked out by employing two different methods. The first method consists of running silver nitrate tests on scale infested stems, and the second of preparing histological sections of scale infested tissue. These two methods, carried out at the Berkeley Laboratory, should show the type of injury produced by feeding Matsucoccus scale, and the effect this has upon the physiological functions of the tree.